

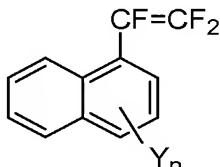
Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Previously Presented) A fluorinated ion exchange polymer prepared by grafting a monomer on to a base polymer, wherein the grafting monomer is selected from the group consisting of structure **1a**, structure **1b** and mixtures thereof,



1a



1b

wherein for **1a** and **1b**, Y is independently selected from the group consisting of -R_FSO₂F (sulfonyl fluoride), -R_FSO₃M (fluorosulfonic acid or salt), -R_FSO₂NH₂ (fluorosulfonamide), and -R_FSO₂N(M)SO₂R²_F (imide); wherein M is H, an alkali cation, or ammonium; and R_F and R²_F groups are perfluorinated or partially fluorinated, and may optionally include ether oxygens; and

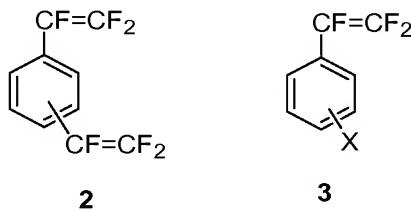
n is between 1 and 2 for **1a**, or n is between 1 and 3 for **1b**.

2. (Original) The fluorinated ion exchange polymer of claim 1 wherein Y is -R_FSO₂F.

3. (Original) The fluorinated ion exchange polymer of claim 1 wherein R_F is selected from the group consisting of (CF₂)_q wherein q = 1 to 20, (CF₂)_qOCF₂CF₂ wherein q = 0 to 12, and (CF₂CF(CF₃)O)_qCF₂CF₂ wherein q = 1 to 8, and R²_F is selected from the group consisting of methyl, ethyl, propyl, butyl, and phenyl, each of which may be partially fluorinated or perfluorinated.

4. (Original) The fluorinated ion exchange polymer of claim 3 wherein R_F is selected from the group consisting of (CF₂)_q wherein q = 1 to 4, (CF₂)_qOCF₂CF₂ wherein q = 0 to 6, and (CF₂CF(CF₃)O)_qCF₂CF₂ wherein q = 1 to 2, and R²_F is selected from the group consisting of perfluoromethyl, perfluoroethyl, and perfluorophenyl.

5. (Original) The fluorinated ion exchange polymer of claim 1 wherein the grafting monomers further comprise co-monomers selected from the group consisting of compounds containing a single vinyl group, compounds containing multiple vinyl groups, monomers having the structure **2**, monomers having structure **3** and mixtures thereof:



wherein X is hydrogen, halogen, alkyl, or perfluoroalkyl that may include oxygen.

6. (Original) The fluorinated ion exchange polymer of claim 5 wherein the compounds containing single or multiple vinyl groups are divinyl benzene or triallyl cyanurate.

7. (Original) The fluorinated ion exchange polymer of claim 5 wherein the substituents X on co-monomer of structure **3** are selected from the group consisting of hydrogen, halogen; linear or branched perfluoroalkyl groups, wherein the alkyl group comprises C1 to C10 carbon atoms; and a perfluoroalkyl group containing oxygen, chlorine or bromine, wherein the perfluoroalkyl group comprises C1 to C10 carbon atoms.

8. (Original) The fluorinated ion exchange polymer of claim 7 wherein the substituents X on co-monomer of structure **3** are selected from the group consisting of hydrogen, chlorine, fluorine, methyl, ethyl,

methoxy, perfluoromethyl, perfluoroethyl, perfluorobutyl, perfluoromethoxy, and $-\text{CF}_2\text{CF}(\text{CF}_3)\text{OCF}_2\text{CF}_3$.

9. (Original) The fluorinated ion exchange polymer of claim 1 wherein the base polymer is a homopolymer or copolymer of non-fluorinated, fluorinated, and perfluorinated monomers.

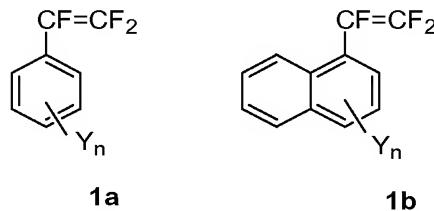
10. (Original) The fluorinated ion exchange polymer of claim 9 wherein the base polymer is selected from the group consisting of poly(ethylene-tetrafluoroethylene), poly(ethylene-chlorotrifluoroethylene), poly(tetrafluoroethylene-hexafluoropropylene), poly(tetrafluoroethylene-perfluoroalkyl vinyl ether), poly(tetrafluoroethylene-perfluoromethyl vinyl ether), poly(tetrafluoroethylene-perfluoropropyl vinyl ether), polytetrafluoroethylene, modified polytetrafluoroethylene, polyvinyl fluoride, polyvinylidene fluoride, poly(vinylidene fluoride-hexafluoropropylene), polyethylene, and polypropylene.

11. (Original) The fluorinated ion exchange polymer of claim 10 wherein the perfluoro(alkyl vinyl ether), is perfluoro(propyl vinyl ether) or perfluoro(ethyl vinyl ether).

12. (Original) The fluorinated ion exchange polymer of claim 2 wherein the base polymer comprises a terpolymer of ethylene, tetrafluoroethylene (TFE), and 1 to 10 mole% of a termonomer such as perfluorobutyl ethylene.

13. (Currently Amended) A fluorinated ion exchange polymer membrane comprising a fluorinated ion exchange polymer prepared by

grafting a monomer on to a base polymer, wherein the grafting monomer is selected from the group consisting of structure **1a**, structure **1b** and mixtures thereof,



wherein for **1a** and **1b**, Y is independently selected from the group consisting of $-\text{R}_F\text{SO}_2\text{F}$ (sulfonyl fluoride), $-\text{R}_F\text{SO}_3\text{M}$ (fluorosulfonic acid or salt), $-\text{R}_F\text{SO}_2\text{NH}_2$ (fluorosulfonamide), and $-\text{R}_F\text{SO}_2\text{N}(\text{M})\text{SO}_2\text{R}_F^2$ (imide); wherein M is H , an alkali cation, or ammonium; and R_F and R_F^2 groups are perfluorinated or partially fluorinated, and may optionally include ether oxygens; and

n is between 1 and 2 for **1a**, or n is between 1 and 3 for **1b**; and wherein the base polymer is a partially or completely fluorinated polymer in film form.

14. (Original) The fluorinated ion exchange membrane of claim 13 wherein the base polymer is a completely fluorinated polymer.

15. (Previously Presented) The fluorinated ion exchange membrane of claim 13 wherein the base polymer is selected from the group consisting of poly(ethylene-tetrafluoroethylene), poly(ethylene-tetrafluoroethylene-termonomer), poly(tetrafluoroethylene-hexafluoropropylene), poly(tetrafluoroethylene-perfluorovinylether), polytetrafluoroethylene, poly(ethylene-chlorotrifluoroethylene); poly(vinylidene fluoride), and poly(vinylidenefluoride-hexafluoropropylene).

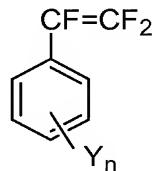
16. (Previously Presented) The fluorinated ion exchange membrane of claim 15 wherein the base polymer is selected from the group consisting of poly(ethylene-tetrafluoroethylene-termonomer), poly(tetrafluoroethylene-

hexafluoropropylene), poly(tetrafluoroethylene-perfluoropropylvinylether), and poly(vinylidene fluoride).

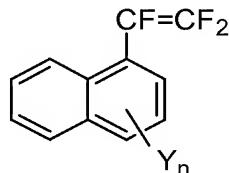
17. (Original) The fluorinated ion exchange membrane of claim 15 wherein the base polymer comprises a terpolymer of ethylene, tetrafluoroethylene (TFE), and 1 to 10 mole% of a perfluorobutyl ethylene.

18. (Currently Amended) A grafting process for making the fluorinated ion exchange polymer membrane comprising:

forming an monomer composition comprising a grafting monomer, in neat form, emulsion form, or solution form, wherein the grafting monomer is selected from the group consisting of structure **1a**, structure **1b** and mixtures thereof,



1a



1b

wherein for **1a** and **1b**, Y is independently selected from the group consisting of -R_FSO₂F (sulfonyl fluoride), -R_FSO₃M (fluorosulfonic acid or salt), -R_FSO₂NH₂ (fluorosulfonamide), and -R_FSO₂N(M)SO₂R²_F (imide); wherein M is H, an alkali cation, or ammonium; and R_F and R²_F groups are perfluorinated or partially fluorinated, and may optionally include ether oxygens; and

n is between 1 and 2 for **1a**, or n is between 1 and 3 for **1b**;

(b) irradiating a base polymer with ionizing radiation, and

(c) contacting the base polymer with the monomer composition from step (a), at a temperature of about 0 °C to about 120 °C for about 0.1 to about 500 hrs.

19. (Original) The process of claim 18 wherein the base polymer is in film form.

20. (Original) The process of claim 18 wherein steps (b) and (c) are performed simultaneously.

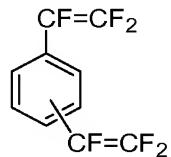
21. (Original) The process of claim 18 wherein steps (b) and (c) are performed sequentially.

22. (Original) The process of claim 18 wherein Y is -R_FSO₂F.

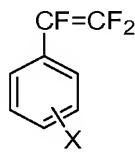
23. (Original) The process of claim 18 wherein R_F is selected from the group consisting of (CF₂)_q wherein q = 1 to 20, (CF₂)_qOCF₂CF₂ wherein q = 0 to 12, and (CF₂CF(CF₃)O)_qCF₂CF₂ wherein q = 1 to 8, and R²_F is selected from the group consisting of methyl, ethyl, propyl, butyl, and phenyl, each of which may be partially fluorinated or perfluorinated.

24. (Original) The process of claim 23 wherein R_F is selected from the group consisting of (CF₂)_q wherein q = 1 to 4, (CF₂)_qOCF₂CF₂ wherein q = 0 to 6, and (CF₂CF(CF₃)O)_qCF₂CF₂ wherein q = 1 to 2, and R²_F is selected from the group consisting of perfluoromethyl, perfluoroethyl, and perfluorophenyl.

25. (Original) The process of claim 18 wherein the grafting monomer further comprises co-monomers selected from the group consisting of compounds containing a single vinyl group, compounds containing multiple vinyl groups, monomers having the structure 2, monomers having structure 3 and mixtures thereof:



2



3

wherein X is hydrogen, halogen, alkyl, or perfluoroalkyl that may include oxygen.

26. (Original) The process of claim 25 wherein the compounds containing single or multiple vinyl groups are divinyl benzene or triallyl cyanurate.

27. (Original) The process of claim 25 wherein the substituents X on co-monomer of structure 3 are selected from the group consisting of hydrogen, halogen; linear or branched perfluoroalkyl groups, wherein the

alkyl group comprises C1 to C10 carbon atoms; and a perfluoroalkyl group containing oxygen, chlorine or bromine, wherein the perfluoroalkyl group comprises C1 to C10 carbon atoms.

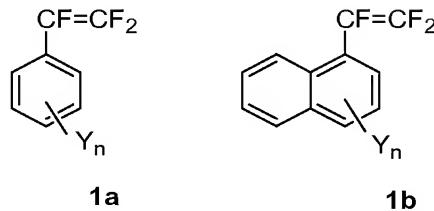
28. (Original) The process of claim 18 wherein the base polymer is a homopolymer or copolymer of non-fluorinated, fluorinated, and perfluorinated monomers.

29. (Original) The process of claim 28 wherein the base polymer is selected from the group consisting of poly(ethylene-tetrafluoroethylene), poly(ethylene-chlorotrifluoroethylene), poly(tetrafluoroethylene-hexafluoropropylene), poly(tetrafluoroethylene-perfluoroalkyl vinyl ether), poly(tetrafluoroethylene-perfluoromethyl vinyl ether), poly(tetrafluoroethylene-perfluoropropyl vinyl ether), polytetrafluoroethylene, modified polytetrafluoroethylene, polyvinyl fluoride, polyvinylidene fluoride, poly(vinylidene fluoride-hexafluoropropylene), polyethylene, and polypropylene.

30. (Original) The process of claim 28 wherein the base polymer is a partially or completely fluorinated polymer.

31. (Previously Presented) The process of claim 30 wherein the base polymer is selected from the group consisting of poly(ethylene-tetrafluoroethylene), poly(ethylene-tetrafluoroethylene-termonomer), poly(tetrafluoroethylene-hexafluoropropylene), poly(tetrafluoroethylene-perfluorovinylether), polytetrafluoroethylene, poly(ethylene-chlorotrifluoroethylene); poly(vinylidene fluoride), and poly(vinylidenefluoride-hexafluoropropylene).

32. (Currently Amended) A catalyst coated membrane comprising a polymer electrolyte membrane having a first surface and a second surface, wherein the polymer electrolyte membrane comprises a fluorinated ion exchange polymer prepared by grafting a monomer on to a base polymer, wherein the grafting monomer is selected from the group consisting of structure **1a**, structure **1b** and mixtures thereof,



wherein for 1a and 1b, Y is independently selected from the group consisting of -R_FSO₂F (sulfonyl fluoride), -R_FSO₃M (fluorosulfonic acid or salt), -R_FSO₂NH₂ (fluorosulfonamide), or -R_FSO₂N(M)SO₂R²_F (imide); wherein M is H, an alkali cation, or ammonium; and R_F and R²_F groups are perfluorinated or partially fluorinated, and may optionally include ether oxygens; and

n is between 1 and 2 for 1a, or n is between 1 and 3 for 1b.

33. (Original) The catalyst coated membrane of claim 32 wherein the base polymer is in film form.

34. (Original) The catalyst coated membrane of claim 32 further comprising at least one electrode prepared from an electrocatalyst coating composition present on the first and second surfaces of the polymer electrolyte membrane.

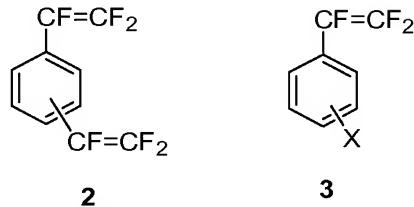
35. (Cancelled)

36. (Cancelled)

37. (Original) The catalyst coated membrane of claim 34 wherein the electrocatalyst coating composition comprises a catalyst and a binder.

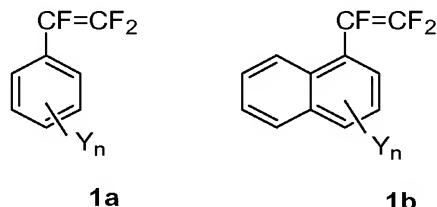
38. (Original) The catalyst coated membrane of claim 37 wherein the binder is a perfluorosulfonic acid polymer.

39. (Original) The catalyst coated membrane of claim 32 wherein the grafting monomer further comprises co-monomers selected from the group consisting of compounds containing a single vinyl group, compounds containing multiple vinyl groups, monomers having the structure 2, monomers having structure 3 and mixtures thereof:



wherein X is hydrogen, halogen, alkyl, or perfluoroalkyl that may include oxygen.

40. (Currently Amended) A membrane electrode assembly comprising a polymer electrolyte membrane, having a first surface and a second surface, wherein the polymer electrolyte membrane comprises a fluorinated ion exchange polymer prepared by grafting a monomer on to a base polymer, wherein the grafting monomer is selected from the group consisting of structure **1a**, structure **1b** and mixtures thereof,



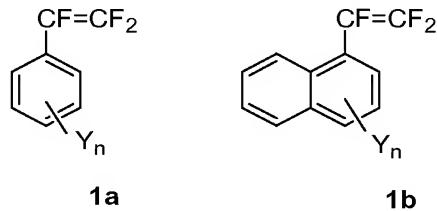
wherein **for 1a and 1b**, Y is independently selected from the group consisting of $-R_FSO_2F$ (sulfonyl fluoride), $-R_FSO_3M$ (fluorosulfonic acid or salt), $-R_FSO_2NH_2$ (fluorosulfonamide), or $-R_FSO_2N(M)SO_2R^2_F$ (imide); wherein M is H, an alkali cation, or ammonium; and R_F and R^2_F groups are perfluorinated or partially fluorinated, and may optionally include ether oxygens; and

n is between 1 and 2 for 1a, or n is between 1 and 3 for 1b.

41 - 59. (Cancelled)

60. (Currently Amended) An electrochemical cell comprising a membrane electrode assembly, wherein the membrane electrode assembly comprises a polymer electrolyte membrane, having a first surface and a second surface, wherein the polymer electrolyte membrane

comprises a fluorinated ion exchange polymer prepared by grafting a monomer on to a base polymer, wherein the grafting monomer is selected from the group consisting of structure **1a**, structure **1b** and mixtures thereof,



wherein for **1a** and **1b**, Y is independently selected from the group consisting of -RFSO2F (sulfonyl fluoride), -RFSO3M (fluorosulfonic acid or salt), -RFSO2NH2 (fluorosulfonamide), or -RFSO2N(M)SO2R2F (imide); wherein M is H, an alkali cation, or ammonium; and R_F and R^2_F groups are perfluorinated or partially fluorinated, and may optionally include ether oxygens; and

n is between 1 and 2 for **1a**, or n is between 1 and 3 for **1b**.

61. (Previously Presented): The electrochemical cell of claim 60 wherein the electrochemical cell is a fuel cell.

62- 72. (Cancelled)